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PROFITABILITY AND TECHNICAL EFFICIENCY IN IRRIGATED ONION PRODUCTION UNDER MIDDLE RIMA VALLEY IRRIGATION PROJECT IN GORONYO, SOKOTO STATE NIGERIA

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ABSTRACT
The study analyzed profitability and technical efficiency in irrigated onion production under Middle Rima valley irrigation project in Goronyo, Sokoto State Nigeria. The primary data used for the study were obtained using structured questionnaire administered to 90 randomly selected farmers. Descriptive statistics, gross margin, net farm income, gross ratio, operation ratio, return on investment and stochastic frontier production function were used to analyze the data. The result showed that estimated gross margin; net farm income; gross ratio; operating ratio; and return on capital investment gives an estimated values of N367,332.73 per hectare, N347,792.54 per hectare, 0.25,0.21 and 3.58 respectively. The mean efficiency obtained was 94.67 percent indicating that there was a 5.33 percent allowance for improving efficiency. The result also showed that, farmers' educational level, years of farming experience and access to extension service significantly influenced the farmers' efficiency positively. It is recommended that relevant policies that would enhance the technical skill of the farmers and access to to extension services should be evolved by the stakeholders.

KEY WORDS: Irrigated Onion Production, Gross Margin, Stochastic Frontier Production Function, Efficiency Measurement.

INTRODUCTION

Onion (*Allium cepa*) is a vegetable crop belonging to the family of Leliaceace (Alabi and Adebayo 2008). Since Onion is essentially an out of season crop, practiced on hydro-agricultural lands, production is concentrated in the north of Nigeria, more specifically in the dry tropical zone. In this light, the greater part of onion production in Nigeria is undertaken in the north of the country specifically in Kaduna, Kano, Jigawa, Katsina, Sokoto, Plateau and Bauchi States. The natural features of these regions, especially the presence of flood prone plains and river basins and above all the development of vast irrigated lands, create conditions that greatly favour the development of this crop. Onion needs drained soil adequately supplied with humus, alluvial types of soil, well-drained fertile loam and most sandy rich in humus. The soil which onion is planted must be capable of retaining moisture during dry season because there is the need for high organic matter content in the soil (Anyanwu, 2003). Onions are good sources of carbohydrates, vitamin A,B and C (Anyanwu, 2003). It is grown and consumed in green state and as mature bulbs (Thompson and Kelly, 1987). The average calculated annual onion consumption was as approximately 6.20kg per person across the world (FAO, 2006). Onions are most often used to enhance flavours in a wide range of recipes, soups, sauces, stews, salad and for seasoning foods (Tanko, 1983).

The bulk of onion production is from the dry season cropping system particularly under irrigation in the Northern States. The importance of irrigation as a means of increasing agricultural productivity necessitated the establishment of River Basin and Rural Development Authorities by the Federal Government of Nigeria in 1979 after which the Middle Rima Valley Irrigation Project, Goronyo was embarked upon in 1984. Okeke *et-al* (2007) reported that the corporate goal of this irrigation project was to ensure a systematic and consistent programme of harnessing developing and conserving available water resources with a view to improving the socio-economic status and quality of life of people living within the catchment areas through the supply of water for irrigation in crop production (especially onion), human and livestock consumption, fisheries development and industrial use. However not much attempts have been made to analyze the profitability and technical efficiency of

onion production under this irrigation scheme. The broad objective of this study is to evaluate the profitability and technical efficiency in irrigated onion production under Middle Rima valley irrigation project in Goronyo, Sokoto State, Nigeria. The specific objectives are to: (i) examine the socio-economic characteristics of sampled farmers in the study area; (ii) evaluate the gross margin of sampled onion farmers under the irrigation scheme and (iii0 estimate efficiency and its determinants in onion production under the irrigation scheme.

Table1: Socio-economic Characteristics of Sampled Farmers.

Variables.	Frequency	Percentage
Sex		
Male	84	93.3
Female	6	6.7
Marital Status		
Single	80	88.9
Married	4	4.4
Divorced	2	2.2
Widow(er)	4	4.4
Age (years)		
21-30	12	13.3
31-40	25	27.8
41-50	36	40.0
51-60	15	16.7
>60	2	2.2
Education		
No Formal Education	44	48.9
Primary	40	44.4
Secondary	4	4.4
Tertiary	2	2.2
Household Size		
1-5	58	64.4
6-10	32	35.6
Years of Farming Experience		
1-5	30	33.3
6-10	48	53.3
11-15	10	11.1
16-20	2	2.2
Means of Land Acquisition		
Owned	42	46.7
Gift	3	3.3
Family	13	14.4
Rented	12	13.3
Inherited	20	22.2

Source: Field Survey, 2008

METHODOLOGY

Study area: The study area covers a total of 17,080 hectares on both sides of the Rima River between the Goronyo Dam near the village of katsire to the north east and about 5km downstream of the village of Shinaka to the south-east between longitude 5^o 39` and $5^o$ 5` east and latitude 13^o 25` and $13^o$ 31` north (MRVI, 2001). The major ethnic groups are Hausa, Fulani and Zabarma who are mainly growers of rice, onion, garlic, wheat, sorghum and other moisture sensitive high value vegetable crops. The climate is sudano-sahel savannah type. The annual rainfall is between 579mm to 674mm with average monthly temperature ranges from 24^oC and 33^oC (Okeke *et al*, 2007).

Sampling Technique: Primary data were collected from ninety respondents who were randomly selected from the list of participating farmers in the Sokoto Rima Basin and Rural Development Authority (SRRBRDA) during 2007 farming season. The data were collected with the use of structured questionnaire designed in line with objectives of the study.

Data Analysis

Descriptive Statistics: The method employs arithmetic mean, frequency distribution, percentage etc. The technique was used to group and summarize the data obtained from the field.

Table2: Estimated Gross Margin Analysis for Irrigated Onion Production

Cost Items and Revenue	Cost (₦ /Ha)	% of Total cost
Variable Cost		
Water	2,883.85	2.36
Labour	26,765.17	21.93
Fertilizer	54,517.95	44.66
Agrochemical	8,557.23	7.01
Seed/Seedling	5,677.38	4.65
Transportation, packaging and handling charges	4,137.79	3.39
Total Variable Cost	102,539.37	83.99
Fixed Cost		
Pump rent and Maintenance	16,257. 09	13.32
Farm tools (Depreciation)	3,282.50	2.69
Total Fixed Cost	19,539.59	16.01
Total Cost	122,078.96	100
Returns		
Gross Income	469,871.50	
Gross Margin	367,332.13	
Net Farm Income	347,792.54	
Returns on Naira Invested	3.58	
Operating Ratio	0.21	
Gross Ratio	0.25	

Source: Field Survey, 2008

Gross margin: This is the difference between the Gross Farm Income (GFI) and the Total Variable Cost (TVC). It is a useful planning tool in situations where fixed capital is negligible portion of the farming enterprises in the case of small scale subsistence agriculture (Olukosi and Erhabor, 1988).

$$GM = GFI - TVC$$

Where GM = Gross Margin, GFI = Gross Farm Income, TVC = Total Variable Cost.

Gross margin analysis is one method of calculating profitability of small scale cropping enterprises (Olukosi *et-al*, 2006).

Gross ratio: This is is a profitability ratio that measures the overall success of the farm. The lower the ratio, the higher the return per naira.

$$GR = \frac{TFE}{GI}$$

Where GR = Gross Ratio, TFE = Total Farm Expenses and GI = Gross Income.

Operating Ratio: The operating ratio is directly related to the farm variable input usage. The lower the ratio, the higher the profitability of the farm business.

$$OR = \frac{TOC}{GI}$$

Where OR = Operating Ratio, TOC = Total Operating Cost and GI = Gross Income.

Return on Capital Invested: This is defined as gross margin divided by total variable cost.

$$RI = \frac{GM}{TVC}$$

Where RI = Return on Capital Invested, GM = Gross Margin and TVC = Total Variable Cost.

Table3: Summary Statistics of the Variables in Stochastic Frontier Model

Variables	Minimum	Maximum	Mean	Standard Deviation
Output (tons)				
Farm Size (ha)	0.70	17.00	4.6030	3.3166
Labour (Man-days)	0.25	2.75	0.53	0.4117
Fertilizer (kg)	110.25	148.38	123.96	75.1631
Agrochemical (Litres)	50.00	2250.00	273.89	263.9616
Age (years)	0.00	17.00	3.57	3.2998
Household Size	25.00	65.00	42.77	9.3159
Education Level (years)	1.00	10.00	1.65	1.5152
Years of Experience	0.00	13.00	5.24	4.0260
Number of Extension	2.00	20.00	7.67	3.7716
Contact	0.00	4.00	2.31	0.6811

Source: Field Survey, 2008

Production Function Analysis: A stochastic frontier production function that incorporated inefficiency factors were estimated using Maximum Likelihood Estimation (MLE) technique to obtain farm specific technical efficiencies as well as their determinants. The stochastic frontier production function was specified as:

$$LnY_i = \beta_0 + \sum \beta_j LnX_{ij} + V_i - U_i$$

Where
Ln = Natural logarithm;
I = ith sampled smallholder farm;
Y = Value of farm output from farm I;
Xs = input variables in the model, and
X1 = Farm Size (in hectares);
X2 = Labour (in man-day);
X3 = Fertilizer (kg);
X4 = Herbicides (litres); ;
β3 = Input coefficients for the resources used in production;
Ui = Farmer specific characteristics related to production efficiency;
Vi = Statistically disturbance term.

The explicit form of the Cobb-Douglas functional form is written thus:

$$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + V_1 - U_1$$

Where Y1, X1, X2, X3, X4 and X5 are as defined earlier. The Vi's are assumed to be independent and identically distributed (iid) normal random errors having zero mean and unknown variance. Ui's are non-negative random variables called technical inefficiency of production of the respondent farmers which are assumed to be independent of the Vi's such that Ui's are the non-negative truncation. (at zero) at the normal distribution with mean μ and variance δ2

$$\mu = \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i} + \delta_5 Z_{5i}$$

Z1, Z2, Z3, Z4 and Z5 are the age, household size, level of education, years of farming experience and access to extension agents (number of contact) of the i^{th} farmers respectively and the βs and δs are known scalar parameters to be estimated.

The variables like age, household size, level of education, years of farming experience and access to extension agents were included in the model for the technical inefficiency effects to include positive effects of farmers characteristics on the efficiency of production.

Table4: Maximum Likelihood Estimates of Parameters of the Cobb-Douglas Frontier Function for Irrigated Onion Production in Goronyo, Sokoto State.

Variables	Parameters	Coefficients	t-ratio
General Model			
Constant	ß0	-45.548	-19.750***
Farm Size (ha) (X1)	ß1	0.175	3.060***
Labour (Man-days) (X2)	ß2	-0.194	-2.403***
Fertilizer (kg) (X3)	ß3	8.145	51.046***
Herbicide (Litres) (X4)	ß4	0.252	2.427***
Inefficiency Functions			
Constant	δ0	0.090	0.175N.S
Age (years)	δ1	0.026	0.313N.S
Household Size	δ2	0.007	0.215N.S
Education Level (years)	δ3	-0.043	-2.609***
Farming Experience (years)	δ4	-0.022	-1.813**
Extension Contact	δ5	-0.047	-4.84***
Diagnosis Statistics			
Sigma-square δ^2		0.7672	6.059***
Gamma γ		0.2782	7.393***
Log likelihood function		-9.43	
LR Test		2.43	

Source: Computed from MLE Results
* = Significant at 10% level; ** = Significant at 5% level; *** = Significant at 1% level. NS = Not significant

The technical efficiency of the farmers is expressed as:

$$TE_i = \exp(-Ui)$$

RESULTS AND DISCUSSION

Socio-economic characteristics of sampled farmers: Some socio-economic characteristics may influence onion in the area. The variables analyzed in this study include sex, marital status, age, education, household size, years of farming experience and means of land acquisition. Table1 shows that majority of the respondents (93.3%) were males. This is a manifestation of gross inequality in gender distribution and calls for concerted effort in empowering the women to contribute their own quota to production in the study area. It is also shown in the table that 67.8% of the sampled farmers were between the ages of 30 and 50 years. Thus, majority of the sampled farmers were middle aged, which could result in a positive effect on production. The modal class of educational level of respondents was non-formal education (48.9) followed by primary education (44.4%). This is not surprising outcome as the study area falls within educationally disadvantaged states of Nigeria. Only 2.2% had tertiary education. Table1 also showed that 64.4% of the farmers had less than 6 family members while 35.6% had 6 to 10 members. Generally, in agrarian settlements, a large family size guarantees free and cheap labour. The table revealed that 88.6% of the farmers were within the range of 0-10years farming experience, while13.3% had 11years and above farming experience.

Gross Margin Analysis of Irrigated Onion Farmers: The estimated gross margin analysis for irrigated onion farmers is shown in Table2. The table showed that cost of fertilizer constituted 44.66 percent of the total cost of production in irrigated onion farming followed by labour, pump rent and maintenance with 21.93 and 13.32percents respectively. A confirmation of profitability of irrigated onion production

is shown by a net income of ₦347, 792.54. Also, the return on a naira invested was ₦3.58 while gross and operating ratios were 0.21 and 0.25 respectively. All the ratios were less than 1 indicating profitability of the farming.

Production Analysis: The summary statistics of the variables for the frontier estimation is presented in Table3. They include the sample mean and the standard deviation for each of the variables. The mean of 4.6030tons of onion per annum was obtained from the data analysis with a standard deviation of 3.3166

The large size of the standard deviation confirmed that most farms operate at different scales of operation. Analysis of the inputs also revealed an average farm size of 0.53ha per farmer an indication that the study covered small scale family managed farm units. The average labour of 123.96 man- day showed that onion farmers relied heavily on human labour to do most of the farming operations.
The analysis of other input variables showed the mean values of 263.96kg and 3.30litres for fertilizer and herbicides respectively. All these findings point to the characteristic nature of subsistence farming which dominates agricultural production in Nigeria.

Variables representing the demographic characteristics of the sampled farmers employed in the analysis of the determinant of technical efficiency include age of the farmers, household size, educational level of the farmers, years of experience and number of extension contacts. The average age of the farmers, household size, year of schooling, years of experience and number of extension contact were 42.77, 1.65, 5.24, 7.67 and 2.31 respectively, meaning that the farmers were relatively young and uneducated.

Table5: Distribution of Technical Efficiency Indices among Farmers in the Study Area

Efficiency Index	Class	Frequency	Percentage
0.00 - 0.10		0	0
0.11 – 0.20		0	0
0.21 – 0.30		0	0
0.31 – 0.40		0	0
0.41 – 0.50		0	0
0.51 – 0.60		0	0
0.61 – 0.70		0	0
0.71 – 0.80		0	0
0.81 – 0.90		7	7.78
0.91 – 1.00		83	92.22
Total		90	100.00
Mean		0.9467	
Maximum value		0.9993	
Minimum value		0.8755	

Source: Computed from MLE Results

The stochastic frontier production function estimates of irrigated onion producers in the Goronyo, Sokoto State are presented in Table 4. The Table showed that the coefficients of land, fertilizer and agrochemical had the expected positive signs which indicated that a unit increase in these inputs will lead to increase in the gross output of irrigated onion. These variables were statistically significant at 1% level. The coefficient of labour is negative. The estimated elasticities of mean output with respect to land, labour and fertilizer inputs were 0.175, -0.194, 8.145 and 0.252 respectively. This means that for 1% increase in area cultivated to irrigated onion, the output will increase by 17.5%. 1% increase in the amount of fertilizer and herbicide applied to onion also increased onion output by 814.5% and 25.2% respectively. However, a 1% increase in labour decreased onion output by 19.4%. The elasticity estimates of land, fertilizer and herbicide are statistically significant at 1% levels. The sum of the elasticity (8.378) indicated that, the irrigated onion farmers were operating in the increasing return to scale region

The estimated coefficients of the inefficiency function provide some explanations for the relative efficiency levels among individuals' farms. Since the dependent variable of the inefficiency function represents the mode of inefficiency, a positive sign of an estimated parameter implies that the associated variable has a negative effect on efficiency and a negative sign indicates the reverse. The negative coefficients for education, farming experience and extension contacts imply that educated farmers, the farmers with high farming experience and extension contacts in irrigated onion production were more technically efficient meaning that as the level of education, years of farming experience and access to extension services increased in the study area, the technical inefficiency of the farmers decreases. Also, negative coefficient for age and household size implied that the farmers' level of technical inefficiency declined with increase in age and household size.

The sigma square (0.7672) is large and statistically significant at 1 percent. This indicates a good fit and the correctness of the specified distributed assumption of the composite error term. The gamma (γ) ratio of 0.2782 which is significant at 1% level implied that about 27.82 percent variation in the output of irrigated onion farmers was due to differences in their technical efficiencies.

Technical Efficiency Estimates of the Farmers

The technical efficiency indices were derived from the MLE results of the stochastic production function, using computer programme FRONTIER 4.1. The indices in Table5 showed that the technical efficiency of the sampled farmers was less than one (less than 100%), implying that all the farmers in the study area were producing below the maximum efficiency frontier.

Some farmers demonstrated a range of technical efficiency of 0.9993 (99.93%) while the worst farmer had a technical efficiency of 0.8755 (87.55%). The mean technical efficiency is 0.9467 (94.67%), implying that on the average, farmers in the study area were able to obtain a little over 90percent of potential irrigated onion output from a given mix of production inputs. From the results obtained, although farmers were generally relatively efficient, they still have room to increase the efficiency in their farming activities as about 5.33 percent efficiency gap from optimum (100%) was yet to be attained by all farmers.

SUMMARY AND CONLUSION

This empirical study is on profitability and technical efficiency of irrigated onion production under Middle Rima valley irrigation project in Goronyo, Sokoto State Nigeria. The study showed that irrigated onion production was profitable with a net income of ₦347, 792.54 per hectare. A Cobb-Douglas production frontier was estimated by maximum likelihood estimation method to obtain ML estimates and inefficiency determinants. The MLE results revealed that TE of irrigated onion farmers varied due to the presence of technical inefficiency effects in onion production. Size of farmland, labour, fertilizer and agrochemical were found to be the significant production factors which accounted for changes in the output of irrigated onion. The distribution of the technical efficiency indices revealed that most of the farmers were technically efficient with mean TE index of 0.9467 (about 92.22% of the farmers had technically efficiency above 90%). The results of the inefficiency model showed that the years of education, farming experience and number of extension contacts significantly increased the farmers' technical efficiency.

This study showed that irrigated onion farmers were not fully technically efficient and therefore there is allowance of efficiency improvement by addressing some important policy variables that could negatively and positively influence farmers' levels of technical efficiency in the area.

POLICY IMPLICATION AND RECOMMENDATIONS

The policy implication of this study is that there is scope for raising the present level of technical efficiency of onion production in the study area given the variation in the levels of technical efficiency i.e. the mean technical efficiency of 0.9467 could be increased by 5.33% through better use of available resources. It was shown that education (years of schooling) had a positive correlation with technical efficiency and therefore farmers should be encouraged to improve their levels of education by registering in Adult/Continuing Education Centers in the area. It is also recommended that more dams

should be constructed and irrigation equipments be provided for the farmers in the area to supply water for irrigation of farmland. Extension agents should be provided to disseminate research findings to farmers on modern technology.

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